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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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In the Matter of	)	
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Federal-State Joint Board on Universal Service	)	CC Docket No. 96-45
	)	
Forward-Looking Mechanism for High Cost Support for Non-Rural LECs	)	CC Docket No. 97-160

FURTHER NOTICE OF PROPOSED RULEMAKING

Adopted: May 27, 1999 **Released: May 28, 1999**

By the Commission: Commissioner Furchtgott-Roth dissenting and issuing a statement at a later date.

Comment Date: July 2, 1999
Reply Date: July 16, 1999

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I. INTRODUCTION

1. In the Telecommunications Act of 1996 (1996 Act),[1] Congress directed this Commission and the states to take the steps necessary to establish support mechanisms to ensure the delivery of affordable telecommunications service to all Americans. In response to this directive, the Commission has taken action to put in place a universal service support system that will be sustainable in an increasingly competitive marketplace. In the *Universal Service Order*, the Commission adopted a plan for universal service support for rural, insular, and high cost areas to replace longstanding federal subsidies to incumbent local telephone companies with explicit, competitively neutral federal universal service support mechanisms.[2]

[1] Pub. L. No. 104-104, 110 Stat. 56. The 1996 Act amended the Communications Act of 1934, 47 U.S.C. §§ 151 *et. seq.* (Act). Hereinafter, all citations to the Act will be to the relevant section of the United States Code unless otherwise noted.

[2] *Federal-State Joint Board on Universal Service*, Report and Order, CC Docket No. 96-45, 12 FCC Rcd 8776 (1997) (*Universal Service Order*), as corrected by *Federal-State Joint Board on Universal Service*, Errata, CC Docket No. 96-45, FCC 97-157 (rel. June 4, 1997), appeal pending in Texas Office of Public Utility Counsel v. FCC and USA, No. 97-60421 (5th Cir. 1997).

The Commission adopted the recommendation of the Federal-State Joint Board on Universal Service (Joint Board) that an eligible carrier's level of universal service support should be based upon the forward-looking economic cost of constructing and operating the network facilities and functions used to provide the services supported by the federal universal service support mechanisms.[3]

2. Our plan to adopt a mechanism to estimate forward-looking cost has proceeded in two stages. On October 28, 1998, with the release of the *Platform Order*, the Commission completed the first stage of this proceeding: the selection of the model platform. The platform encompasses the aspects of the model that are essentially fixed, primarily the assumptions about the design of the network and network engineering.[4] In this Further Notice, we move toward completion of the second stage of this proceeding, by proposing input values for the model, such as the cost of cables, switches, and other network components, in addition to various capital cost parameters. For the most important inputs, we provide a description of the methodology we have used to arrive at the proposed values.[5] In addition, we seek to supplement the record regarding certain inputs to the model.

3. The forward-looking cost of providing supported services estimated by the model will be used to determine high cost support for non-rural carriers beginning January 1, 2000.[6] The Commission is adopting a companion Order and Further Notice that establishes the framework for determining federal high cost support levels and seeks comment on the details of that mechanism.[7]

II. PROCEDURAL HISTORY

[3] *Universal Service Order*, 12 FCC Rcd at 8888, para. 199. The Commission also determined that high cost support for rural carriers should continue essentially unchanged and should not be based on forward-looking costs until 2001, at the earliest. *Universal Service Order*, 12 FCC Rcd at 8889, para. 203. The Commission adopted the Joint Board's recommendation to define "rural carriers" as those carriers that meet the statutory definition of a "rural telephone company." *Universal Service Order*, 12 FCC Rcd at 8943, para. 310 (*citing* 47 U.S.C. § 153(37)).

[4] *Federal-State Joint Board on Universal Service*, Fifth Report and Order, CC Docket Nos. 96-45, 97-160, 13 FCC Rcd 21323 (1998) (*Platform Order*).

[5] Appendix A contains a complete list of the input values that we propose in this Further Notice.

[6] *Federal-State Joint Board on Universal Service, Access Charge Reform*, Seventh Report and Order and Thirteenth Order on Reconsideration in CC Docket No. 96-45; Fourth Report and Order in CC Docket No. 96-262; and Further Notice of Proposed Rulemaking, CC Docket Nos. 96-45, 96-262, FCC 99-119 (rel. May 28, 1999) (*Companion Order*).

[7] *Id.*

A. *Universal Service Order*

4. Prior to the 1996 Act, three explicit universal service programs were in place to provide assistance to small incumbent local exchange carriers (LECs) and LECs that served rural and high cost areas: high cost loop support,[8] dial equipment minutes (DEM) weighting, and the Long-Term Support (LTS) program.[9] Other mechanisms also have historically contributed to maintaining affordable rates in rural areas, including subsidies implicit in geographic toll rate averaging, intrastate rates, and interstate access charges. In the 1996 Act, Congress codified the Commission's long-standing commitment to ensuring universal service and directed that "[c]onsumers . . . in rural, insular, and high cost areas should have access to telecommunications and information services . . . that are reasonably comparable to those services provided in urban areas and that are available at rates that are reasonably comparable to [those] in urban areas."[10] The 1996 Act also directed the Commission to reform universal service support mechanisms to ensure that they are compatible with the pro-competitive goals of the 1996 Act. Section 254 required the Commission to institute a Joint Board on universal service and implement the recommendations from the Joint Board by May 8, 1997.[11] After receiving the recommendations of the Joint Board on November 7, 1996,[12] the Commission adopted the *Universal Service Order* on May 7, 1997.

5. In the *Universal Service Order*, the Commission adopted a forward-looking economic cost methodology to calculate support for non-rural carriers. Under this methodology, a forward-looking economic cost mechanism selected by the Commission, in consultation with the Joint Board, would be used to calculate non-rural carriers' forward-looking economic cost of providing the supported services in high cost areas.[13]

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[8] Although the existing high cost loop fund has historically been known as the "Universal Service Fund," we will avoid this terminology because of the confusion it may create with the new universal service support mechanisms that the Commission has created pursuant to section 254 of the Communications Act.

[9] The Commission's rules governing these programs are set forth at 47 C.F.R. §§ 36.601 *et. seq.* (high cost loop fund); 47 C.F.R. § 36.125(b) (DEM weighting); and 47 C.F.R. §§ 69.105, 69.502, 69.603(e), 69.612 (LTS).

[10] 47 U.S.C. § 254(b)(3).

[11] 47 U.S.C. § 254(a).

[12] *Federal-State Joint Board on Universal Service*, Recommended Decision, CC Docket No. 96-45, 12 FCC Rcd 87 (1996) (*First Recommended Decision*).

[13] *Universal Service Order*, 12 FCC Rcd at 8890, para. 206. In the *Universal Service Order*, the Commission concluded that the federal universal service support mechanism would support 25 percent of the difference between the forward-looking economic cost of providing the supported service and a nationwide revenue benchmark. *See Universal Service Order*, 12 FCC Rcd at 8888, para. 201. In response to issues raised

B. *Further Notice* and the Input Value Development Process

6. In a July 18, 1997 *Further Notice of Proposed Rulemaking*, the Commission established a multi-phase plan to develop a federal mechanism that would send the correct signals for entry, investment, and innovation.[14] The *1997 Further Notice* divided questions related to the cost models into "platform design" issues and "input value" issues.[15] The *1997 Further Notice* subdivided each of the platform and input issues into four topic groups, and sought comment on each group separately in order to develop a focused dialogue among interested parties. The four groups were: (1) customer location; (2) outside plant design; (3) switching and interoffice; and (4) general support facilities (GSF) and expense issues.[16]

7. After reviewing the comments received in response to the *1997 Further Notice*, the Common Carrier Bureau (Bureau) released two public notices to guide parties wishing to submit cost models for consideration as the federal mechanism.[17]

8. In addition to the 1997 *Further Notice*, the Bureau has solicited comment and allowed interested parties the opportunity to participate in the development of the input values to be used in the forward-looking mechanism. On May 4, 1998, the Bureau released a *Public*

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by commenters and state Joint Board members, the Commission referred back to the Joint Board questions related to how federal support should be determined. *See Federal-State Joint Board on Universal Service*, Order and Order on Reconsideration, CC Docket No. 96-45, 13 FCC Rcd 13749 (1998) (*Referral Order*). *See also Federal-State Joint Board on Universal Service*, Second Recommended Decision, CC Docket No. 96-45, 13 FCC Rcd 24744 (1998) (*Second Recommended Decision*).

[14] *Federal-State Joint Board on Universal Service, Forward-Looking Mechanism for High Cost Support for Non-Rural LECs*, CC Docket Nos. 96-45, 97-160, Further Notice of Proposed Rulemaking, 12 FCC Rcd 18514 at 18519, para. 5 (1997) (*1997 Further Notice*).

[15] Generally, there is a platform component for each portion of the exchange network being modeled. Examples of platform design issues are the establishment of switch capacity limitations and the routing of feeder and distribution cables. Examples of input values are the price of various network components, their associated installation and placement costs, and capital cost parameters such as debt-equity ratios. *See 1997 Further Notice*, 12 FCC Rcd at 18516-18, paras. 17-18.

[16] *See generally 1997 Further Notice.*

[17] *Guidance to Proponents of Cost Models in Universal Service Proceeding: Switching, Interoffice Trunking, Signaling, and Local Tandem Investment*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 97-1912 (rel. Sep. 3, 1997) (*Switching and Transport Public Notice*); *Guidance to Proponents of Cost Models in Universal Service Proceeding: Customer Location and Outside Plant*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 97-2372 (rel. Nov. 13, 1997) (*Customer Location & Outside Plant Public Notice*).

Notice to update the record on several input-related issues.[18] The Bureau also issued data requests designed to acquire information that may be useful in determining the final input values,[19] and conducted a series of public workshops designed to elicit further comment from interested parties in selecting final input values.[20] Finally, the Bureau conducted numerous *ex parte* meetings with interested parties throughout this proceeding.[21]

C. *Platform Order* and *Second Recommended Decision*

9. In the *Platform Order* released on October 28, 1998, the Commission adopted the forward-looking cost model to be used in determining federal universal service high cost support for non-rural carriers.[22] The model platform that the Commission adopted combined elements from each of the three models under consideration in this proceeding: (1) the BCPM, Version 3.0 (BCPM);[23] (2) the HAI Model, Version 5.0a (HAI);[24] and (3) the Hybrid Cost Proxy Model, Version 2.5 (HCPM).[25] In the *Platform Order*, the Commission also specified several issues that would be addressed in the inputs stage of this proceeding. These

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[18] *Common Carrier Bureau Requests Further Comment On Selected Issues Regarding The Forward-Looking Economic Cost Mechanism For Universal Service*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 98-848 (rel. May 4, 1998) (*Inputs Public Notice*).

[19] *Federal-State Joint Board on Universal Service*, Order, CC Docket No. 96-45, 12 FCC Rcd 9803 (1997) (*1997 Data Request*).

[20] *Common Carrier To Hold Three Workshops On Input Values To Be Used To Estimate Forward-Looking Economic Costs For Purposes Of Universal Service Support*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 98-2406 (rel. Nov. 25, 1998) (*Workshop Public Notice*).

[21] *See, e.g.*, Letter from W. Scott Randolph, GTE, to Magalie Roman Salas, FCC, dated March 2, 1999; Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated, February 26, 1999; Letter from Chris Frentrup, MCI, to Magalie Roman Salas, FCC, dated February 9, 1999.

[22] *Platform Order*, 13 FCC Rcd at 21325, para. 4.

[23] Submission in CC Docket Nos. 96-45 and 97-160 by BellSouth Corporation, BellSouth Telecommunications, Inc., U S WEST, Inc., and Sprint Local Telephone Company (BCPM proponents), dated Dec. 11, 1997 (BCPM Dec. 11, 1997 submission).

[24] Letter from Richard N. Clarke, AT&T, to Magalie Roman Salas, FCC, dated Dec. 11, 1997 (HAI Dec. 11, 1997 submission). HAI was submitted by AT&T and MCI (HAI proponents). Versions of HAI filed before February 3, 1998, were known as the Hatfield Model. The proponents refer to the February 3, 1998 submission as HAI. We refer to this model as HAI throughout this Report and Order.

[25] HCPM was developed by Commission staff members William Sharkey, Mark Kennet, C. Anthony Bush, Jeff Prisbrey, and Commission contractor Vaikunth Gupta of Panum Communications. *Common Carrier Bureau Announces Release of HCPM Version 2.0*, Public Notice, DA 97-2712 (rel. Dec. 29, 1997). United States Government Memo from W. Sharkey, FCC, to Magalie Roman Salas, FCC, dated Feb. 6, 1998.

issues include: (1) the geocode data source to determine customer locations;[26] (2) the road surrogate method to determine the location of non-geocoded customer locations;[27] and (3) the use of the local exchange routing guide (LERG) to identify the existing host-remote switch relationships.[28]

10. On November 25, 1998, the Joint Board released the *Second Recommended Decision*, in which it recommended that the Commission compute federal high cost support for non-rural carriers through a two-step process.[29] First, the Joint Board recommended that the Commission should estimate the total support amount necessary in those areas considered to have high costs relative to other areas. Second, the Commission should consider, in a consistent manner across all states, any particular state's ability to support high cost areas within the state.[30] The Joint Board recommended that federal support should be provided to the extent that the state would be unable to support its high cost areas through its own reasonable efforts.[31] In addition, the Joint Board recommended that the Commission continue to work with the Joint Board to select the input values to complete a forward-looking cost model and to finalize the methodology for distributing federal high cost support.[32]

III. ESTIMATING FORWARD-LOOKING ECONOMIC COST

A. Designing a Forward-Looking Wireline Local Telephone Network

11. To understand the assumptions made in the mechanism, it is necessary to understand the layout of the current wireline local telephone network.[33] In general, a telephone network must allow any customer to connect to any other customer. In order to

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[26] *Platform Order*, 13 FCC Rcd at 21338, para. 34.

[27] *Platform Order*, 13 FCC Rcd at 21341, para. 41.

[28] *Platform Order*, 13 FCC Rcd at 21355, para. 76. The LERG is a database of switching information maintained by Bellcore that includes the existing host-remote relationships.

[29] *Second Recommended Decision*, 13 FCC Rcd at 24746, para. 5.

[30] *Second Recommended Decision*, 13 FCC Rcd at 24746, para. 5.

[31] *Second Recommended Decision*, 13 FCC Rcd at 24746-47, para. 5.

[32] *Second Recommended Decision*, 13 FCC Rcd at 24757, para. 28.

[33] We also note that technologies such as wireless services are likely to become more important over time in providing universal service. We will continue to review suggestions for incorporating such technologies into the forward-looking mechanism for future years. *See, e.g.*, Letter from David L. Sieradzki, on behalf of Western Wireless, to Magalie Roman Salas, FCC, dated January 26, 1999 (submitting the "Wireless Cost Model").

accomplish this, a telephone network must connect customer premises to a switching facility, ensure that adequate capacity exists in that switching facility to process all customers' calls that are expected to be made at peak periods, and then interconnect that switching facility with other switching facilities to route calls to their destinations. A *wire center* is the location of a switching facility. The wire center boundaries define the area in which all customers are connected to a given wire center. The *Universal Service Order* required the models to use existing incumbent LEC wire center locations in estimating forward-looking cost.[34]

12. Within the boundaries of each wire center, the wires and other equipment that connect the central office to the customers' premises are known as *outside plant*. Outside plant can consist of either copper cable or a combination of optical fiber and copper cable, as well as associated electronic equipment. Copper cable generally carries an analog signal that is compatible with most customers' telephone equipment, but thicker, more expensive cables or loading coils must be used to carry signals over greater distances. Optical fiber cable carries a digital signal that is incompatible with most customers' telephone equipment, but the quality of a signal carried on optical fiber cable is superior at greater distances when compared to a signal carried on copper wire. Generally, when a neighborhood is located too far from the wire center to be served with copper cables alone, an optical fiber cable will be deployed to a point within the neighborhood, where a piece of equipment will be placed that converts the digital light signal carried on optical fiber cable to an analog, electrical signal that is compatible with customers' telephones. This equipment is known as a digital loop carrier remote terminal, or DLC. From the DLC, copper cables of varying gauge extend to all of the customer premises in the neighborhood. Where the neighborhood is close enough to the *wire center* to serve entirely on copper cables, a copper trunk connects the wire center to a central point in the serving area, called the serving area interface (SAI), and copper cables will then connect the SAI to the customers in the serving area. The portion of the loop plant that connects the central office with the SAI or DLC is known as the *feeder plant*, and the portion that runs from the DLC or SAI throughout the neighborhood is known as the *distribution plant*.

13. The model's estimate of the cost of serving the customers located within a given wire center's boundaries includes the calculation of switch size, the lengths, gauge, and number of copper and fiber cables, and the number of DLCs required. These factors depend, in turn, on how many customers the wire center serves, where the customers are located within the wire center boundaries, and how they are distributed within neighborhoods. Particularly in rural areas, some customers may not be located in neighborhoods at all but, instead, may be scattered throughout outlying areas. In general, the model divides the area

[34] The *Universal Service Order* established ten criteria to ensure consistency in calculations of federal universal service support. *Universal Service Order*, 12 FCC Rcd at 8913, para. 250. Criterion 1 requires that a model must include incumbent LECs' wire centers as the center of the loop network and the outside plant should terminate at incumbent LECs' current wire centers.

served by the wire center into smaller areas known as *serving areas*. For serving areas sufficiently close to the wire center, copper feeder cable extends from the wire center to a SAI where it is cross-connected to copper distribution cables. If the feeder is fiber, it extends to a DLC terminal in the serving area, which converts optical digital signals to analog signals. Individual circuits from the DLC are cross-connected to copper distribution cables at the adjacent SAI.

14. The model assumes that wire centers are interconnected with one another using optical fiber networks known as Synchronous Optical Network (SONET) rings.[35] The infrastructure to interconnect the wire centers is known as the *interoffice* network, and the carriage of traffic among wire centers is known as *transport*. In cases where a number of wire centers with relatively few people within their boundaries are located in close proximity to one another, it may be more economical to use the processor capacity of a single switch to supervise the calls of the customers in the boundaries of all the wire centers. In that case, a full-capacity switch (known as a *host*) is placed in one of the wire centers and less expensive, more limited-capacity switches (known as *remotes*) are placed in the other wire centers. The remotes are then connected to the host with interoffice facilities. Switches that are located in wire centers with enough customers within their boundaries to merit their own full-capacity switches and that do not serve as hosts to any other wire centers are called *stand-alone* switches.

15. There are also a number of expenses and general support facilities (GSF) costs associated with the design of a forward-looking wireline telephone network.[36] GSF costs include the investment related to vehicles, land, buildings, and general purpose computers. Expenses include: plant specific expenses, such as maintenance of facilities and equipment expenses; plant non-specific expenses, such as engineering, network operations, and power expenses; customer service expenses, such as marketing, billing, and directory listing expenses; and corporate operations expenses, such as administration, human resources, legal, and accounting expenses.[37]

B. Synthesis Model

16. The "synthesis" model adopted in the *Platform Order* allows the user to estimate the cost of building a telephone network to serve subscribers in their actual

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[35] SONET is a set of standards for optical (fiber optic) transmission. It was developed to meet the need for transmission speeds above the T3 level (45 Mbps) and is generally considered the standard choice for transmission devices used with broadband networks. BCPM Dec. 11 submission, Model Methodology at 68.

[36] *See Platform Order*, 13 FCC Rcd at 21357-61, paras. 81-91.

[37] *Platform Order*, 13 FCC Rcd at 21357-58, para. 82.

geographic locations, to the extent these locations are known.[38] To the extent that the actual geographic locations of customers are not available, the Commission determined that the synthesis model should assume that customers are located near roads.[39]

17. Once the customer locations have been determined, the model employs a clustering algorithm to group customers into serving areas in an efficient manner that takes into consideration relevant engineering guidelines.[40] After identifying efficient serving areas, the model designs outside plant to the customer locations.[41] In doing so, the model employs a number of cost minimization principles designed to determine the most cost-effective technology to be used under a variety of circumstances, such as varying terrain and density.[42]

18. The Commission concluded that the federal universal service mechanism should incorporate, with certain modifications, the HAI 5.0a switching and interoffice facilities module to estimate the cost of switching and interoffice transport.[43] The Commission noted that it would consider adopting the LERG at the inputs stage of this proceeding to determine the deployment of host and remote switches.[44] In addition, the Commission adopted the HAI platform module for calculating expenses and capital costs, such as depreciation.[45]

19. The Commission noted that technical improvements to the cost model will continue, both before implementation of the model for non-rural carriers and on an ongoing basis, as necessary.[46] The Commission therefore delegated to the Bureau the authority to make changes or direct that changes be made to the model platform as necessary and appropriate to ensure that the platform of the federal mechanism operates as described in the

[38] *Platform Order*, 13 FCC Rcd at 21337, para. 33. *See also* discussion of customer location data, *infra*.

[39] *Platform Order*, 13 FCC Rcd at 21340-41, para. 40. *See also* discussion of road surrogating method, *infra*.

[40] *Platform Order*, 13 FCC Rcd at 21342, para. 44.

[41] *Platform Order*, 13 FCC Rcd at 21346, para. 55.

[42] *Platform Order*, 13 FCC Rcd at 21348, para. 61.

[43] *Platform Order*, 13 FCC Rcd at 21354-55, para. 75.

[44] *Platform Order*, 13 FCC Rcd at 21355, para. 76.

[45] *Platform Order*, 13 FCC Rcd at 21357, para. 81.

[46] *Platform Order*, 13 FCC Rcd at 21329, para. 13.

Platform Order.[47] As contemplated in the *Platform Order*, Commission staff and interested parties have continued to review the model platform to ensure that it operates as intended. As a result, some refinements have been made to the model platform adopted in the *Platform Order*.[48]

C. Selecting Forward-Looking Input Values

20. In the *Universal Service Order*, the Commission adopted ten criteria to be used in determining the forward-looking economic cost of providing universal service in high cost areas.[49] These criteria provide specific guidance for our selection of input values for use in the synthesis model. Rather than reflecting existing incumbent LEC facilities, the technology assumed in the model "must be the least-cost, most-efficient, and reasonable technology for providing the supported services that is currently being deployed."[50] As noted below, existing LEC plant does not necessarily, or even likely, reflect forward-looking technology or design choices.[51] Similarly, the input values we tentatively select in this Notice are not intended to replicate any particular company's embedded or book costs. Criterion three directs that "costs must not be the embedded cost of the facilities, functions, or elements."[52] Rather, the model "must be based upon an examination of the current cost of purchasing facilities and equipment."[53]

21. As discussed in detail in sections V-VIII below, we generally have proposed using nationwide, rather than company-specific input values in the federal mechanism. In many cases, the only data for various inputs on the record in this proceeding are embedded cost, company-specific data. We have used various techniques to convert these data to forward-looking values. For example, we propose modifying the switching data to adjust for the effects of inflation and the cost changes unique to the purchase and installation of digital

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[47] *Platform Order*, 13 FCC Rcd at 21329, para. 13.

[48] *Common Carrier Bureau To Post On The Internet Modifications To The Forward-Looking Economic Cost Model For Universal Service Support*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 98-2533 (rel. Dec. 15, 1998). All changes to the model platform have been posted on the Commission's Web site (http://www.fcc.gov/ccb/apd/hcpm).

[49] *Universal Service Order*, 12 FCC Rcd at 8913-16, para. 250.

[50] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250 (criterion one).

[51] *See infra* at para. 50.

[52] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250 (criterion three).

[53] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250 (criterion three).

switches.[54] We propose nationwide averages, rather than company-specific values, to mitigate the rewards to less efficient companies.[55]

22. Although the BCPM sponsors have provided nationwide default values, they and other LECs generally advocate company-specific input values. For purposes of determining federal universal service support amounts, we believe that nationwide default values generally are more appropriate than company-specific values. Under the new mechanism, support is based on the estimated costs that an efficient carrier would incur to provide the supported services, rather than on the specific carrier's book costs. There may be some categories of inputs, however, where company-specific or state specific input values might be appropriate for use in the federal mechanism. We seek comment on specific alternatives to nationwide values for certain input values, as discussed below.[56] We make no finding with respect to whether nationwide values would be appropriate for purposes other than determining federal universal service support.[57]

IV. DETERMINING CUSTOMER LOCATIONS

A. Background

23. The determination of customer locations relative to the wire center heavily influences a forward-looking cost model's design of outside plant facilities. This is because assumptions about the locations of customers will determine the predicted loop length, which in turn will have a large impact on the cost of service.[58] Each of the models under consideration in the *Platform Order* provided a methodology for determining customer locations.[59] The Bureau sought comment on these proposals and solicited alternative proposals for locating customers from interested parties.[60]

[54] *See infra* para. 166.

[55] *See, e.g., infra* paras. 198, 214.

[56] *See infra* paras. 122, 199-200.

[57] State commissions, for example, may find that it is not appropriate to use nationwide values in determining state universal service support or prices for unbundled network elements and may choose instead to use statewide or company specific values.

[58] *See 1997 Further Notice*, 12 FCC Rcd at 18535, para. 44.

[59] *Platform Order*, 13 FCC Rcd at 21337, para. 31.

[60] *See, e.g., 1997 Further Notice*, 12 FCC Rcd at 18535, para. 44; *Inputs Public Notice* at 3-4; *Common Carrier Bureau Seeks Comment On Model Platform Development*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 98-1587 (rel. Aug. 7, 1998) (*Platform Public Notice*) at 2-4.

24. In the *Platform Order*, the Commission concluded that HAI's proposal to use actual geocode data, to the extent that they are available, and BCPM's proposal to use road network information to create "surrogate" customer locations where actual data are not available, provided the most reasonable method for determining customer locations.[61] The Commission concluded that "the source or sources of geocode data to use in determining customer location will be decided at the inputs phase of this proceeding."[62] The Commission also concluded that "the selection of a precise algorithm for placing road surrogates pursuant to these conclusions should be conducted in the inputs stage of this proceeding as part of the process of selecting a geocode data set for the federal mechanism."[63]

B. Issues for Comment

1. Geocode Data

25. While we affirm our conclusion in the *Platform Order* that geocode data should be used to locate customers in the federal mechanism, we tentatively conclude that at this time we cannot adopt any particular source of geocode data because interested parties have not had adequate access or time to review such data. We tentatively conclude below that a road surrogate algorithm will be used to locate customers in the federal mechanism until a source of geocode data is selected by the Commission. We reiterate our expectation, however, that we will identify and select a source of accurate and verifiable geocode data in the future for use in the federal mechanism.

26. In the *Platform Order*, we concluded that a model is most likely to select the least-cost, most-efficient outside plant design if it uses the most accurate data for locating customers within wire centers, and that the most accurate data for locating customers within wire centers are precise latitude and longitude coordinates for those customers' locations.[64] We noted that commenters generally support the use of accurate geocode data in the federal mechanism where available.[65] We further noted that the only geocode data in the record were those prepared for HAI by PNR Associates (PNR), but that "our conclusion that the model

[61] *Platform Order*, 13 FCC Rcd at 21337, para. 31. Although surrogating methods, and even customer location data provided by the Census Bureau, constitute geocode data, for purposes of clarity, we will use the term "geocode" data to refer only to actual precise latitude and longitude data, unless we specifically refer to the data as "surrogate geocode" data.

[62] *Platform Order*, 13 FCC Rcd at 21337-38, para. 34.

[63] *Platform Order*, 13 FCC Rcd at 21340-41, para. 40.

[64] *Platform Order*, 13 FCC Rcd at 21337, para. 33.

[65] *Platform Order*, 13 FCC Rcd at 21337-38, para. 34.

should use geocode data to the extent that they are available is not a determination of the accuracy or reliability of any particular source of the data."[66] Although commenters support the use of accurate geocode data, several commenters question whether the PNR geocode data are adequately available for review by interested parties.[67]

27. In the *Universal Service Order*, the Commission required that the "model and all underlying data, formulae, computations, and software associated with the model must be available to all interested parties for review and comment."[68] In an effort to comply with this requirement, the Commission has made significant efforts to encourage parties to submit geocode data on the record in this proceeding.[69] PNR took initial steps to comply with this requirement in December 1998 by making available the "BIN" files[70] derived from the geocoded points to interested parties pursuant to the *Protective Order*.[71] In addition, PNR has continued to provide access to the underlying geocode data at its facility in Pennsylvania. Several commenters, in petitions for reconsideration of the *Platform Order*, have argued that the availability of the BIN data alone is not sufficient to comply with the requirements of criterion eight, particularly in light of the expense and conditions imposed by PNR in obtaining access to the geocode point data.[72]

28. We tentatively conclude that interested parties have not had an adequate opportunity to review and comment on the accuracy of the PNR geocode data. We note that a nationwide customer location database will, by necessity, be voluminous, relying on a variety of underlying data sources. In order to comply with criterion eight, all underlying data must be reasonably available to interested parties for review. In light of the concerns expressed by several commenters relating to the conditions and expense in obtaining data

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[66] *Platform Order*, 13 FCC Rcd at 21338, para. 34.

[67] *Platform Order*, 13 FCC Rcd at 21338, para. 34.

[68] *Universal Service Order*, 12 FCC Rcd at 8915, para. 250 (criterion eight).

[69] *See Federal-State Joint Board on Universal Service*, Protective Order, CC Docket Nos. 96-45, 97-160, 13 FCC Rcd 13910 (1998) (*Protective Order*). *See also Inputs Public Notice* at 3-4.

[70] BIN files are the output of the clustering routine in the synthesis model platform derived from the actual geocode customer locations and, as such, do not reveal the actual geocoded customer locations. The BIN files allow users to run all aspects of the model except for the clustering. PNR has made the BIN files available to interested parties for a fee of $25.00, pursuant to the terms of the *Protective Order*. *See* Letter from William M. Newman, PNR, to Magalie Roman Salas, FCC, dated December 17, 1998 (PNR Dec. 17 *ex parte*).

[71] *See* PNR Dec. 17 *ex parte*.

[72] *See, e.g.*, Bell Atlantic Petition for Reconsideration at 5-6; BellSouth Petition for Reconsideration at 3-4; GTE Petition for Reconsideration at 21.

from PNR, we find that no source of geocode data has been made adequately available for review. We anticipate that a source of accurate and verifiable geocode data can be selected for use in the federal mechanism in the future and we encourage parties to make continued efforts to ensure that all underlying geocode data are available for review. For example, we note that PNR has contacted its data vendors for the purpose of making additional underlying data more freely available to parties in this proceeding.[73] As noted in the *Platform Order*, we recognize that more comprehensive geocode data are likely to be available in the future and encourage parties to continue development of a data source that complies with the criteria outlined in the *Universal Service Order* for use in the federal mechanism.[74] We therefore seek further comment on a source of geocode customer locations that will comply with the Commission's criteria for use in the federal mechanism. In addition, we seek comment on the availability for review of the PNR geocode data, including any further measures necessary to ensure that the PNR geocode data are sufficiently available for review by the public.

2. Road Surrogate Customer Locations

29. We tentatively conclude that the road surrogating algorithm proposed by PNR should be used to develop road surrogate customer locations for the federal universal service mechanism. In the *Platform Order,* we concluded that, in the absence of actual geocode customer location data, BCPM's rationale of associating road networks and customer locations provides the most reasonable approach for determining customer locations.[75] As anticipated in the *Platform Order*, once a source of geocode data has been selected, the road surrogate customer locations will be used only in the absence of geocode customer location data.[76]

30. As noted in the *Platform Order*, "associating customers with the distribution of roads is more likely to correlate to actual customer locations than uniformly distributing customers throughout the Census Block, as HCPM proposes, or uniformly distributing customers along the Census Block boundary, as HAI proposes."[77] We therefore concluded in the *Platform Order* that the selection of a precise algorithm for placing road surrogates should be conducted in the inputs stage of this proceeding.[78]

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[73] PNR Dec. 17 *ex parte* at 1.

[74] *Platform Order*, 13 FCC Rcd at 21338, para. 34.

[75] *Platform Order*, 13 FCC Rcd at 21340-41, para. 40.

[76] *Platform Order*, 13 FCC Rcd at 21340-41, para. 40.

[77] *Platform Order*, 13 FCC Rcd at 21340-41, para. 40.

[78] *Platform Order*, 13 FCC Rcd at 21341, para. 41.

31. Currently, there are two road surrogating algorithms on the record in this proceeding - those proposed by PNR and Stopwatch Maps. On March 2, 1998, the HAI proponents provided a description of the road surrogate methodology developed by PNR for locating customers.[79] On January 27, 1999, PNR made available for review by the Commission and interested parties, pursuant to the terms of the *Protective Order*, the road surrogate point data for all states except Alaska, Iowa, Virginia, Puerto Rico and eighty-four wire centers in various other states.[80] On February 22, 1999, PNR filed a more detailed description of its road surrogate algorithm.[81]

32. In general, the PNR road surrogate algorithm utilizes the Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) files, which contain all the road segments in the United States.[82] For each Census Block, PNR determines how many customers and which roads are located within the Census Block.[83] For each Census Block, PNR also develops a list of road segments. The total distance of the road segments within the Census Block is then computed. Roads that are located entirely within the interior of the Census Block are given twice the weight as roads on the boundary. This is because customers are assumed to live on both sides of a road within the interior of the Census Block. In addition, the PNR algorithm excludes certain road segments along which customers are not likely to reside.[84] For example, PNR excludes highway access ramps, alleys, and ferry crossings.[85] The total number of surrogate points is then divided by the computed road distance to determine the spacing between surrogate points. Based on that distance, the

[79] Letter from Michael Lieberman, AT&T, to Magalie Roman Salas, FCC, dated March 2, 1998 (AT&T March 2 *ex parte*).

[80] Letter from William M. Newman, PNR, to Magalie Roman Salas, FCC, dated January 27, 1999 (PNR Jan. 27 *ex parte*). PNR has made available by mail to interested parties the road surrogate point data for a fee of $25.00, pursuant to the terms of the *Protective Order*.

[81] Letter from Charles A. White, PNR, to Magalie Roman Salas, FCC, dated February 22, 1999 (PNR Feb. 22 *ex parte*).

[82] PNR Feb. 22 *ex parte* at 1. A road segment is a length of road between two intersections. The Census Bureau classifies and numbers each of these road segments. PNR uses a slightly modified version of the Census Bureau road classifications. *Id.* at 2

[83] The PNR National Access Line Model is used to determine the number of residential and business customer locations in a given wire center. *See* PNR Feb. 22 *ex parte* at 1.

[84] PNR Feb. 22 *ex parte* at 2.

[85] PNR Feb. 22 *ex parte* at 2.

surrogate customer locations are uniformly distributed along the road segments.[86]

33. Stopwatch Maps has compiled road surrogate customer location files for six states suitable for use in the federal mechanism.[87] We tentatively conclude, however, that until a more comprehensive data set is made available, the Stopwatch data set will not comply with the *Universal Service Order's* criterion that the underlying data are available for review by the public. In addition, we note that the availability of only six states is of limited utility in a nationwide model.

34. We tentatively conclude that the PNR road surrogate algorithm is a reasonable method for locating customers in the absence of actual geocode data. We note that PNR's methodology of excluding certain road segments is consistent with the Commission's conclusion in the *Platform Order* that certain types of roads and road segments should be excluded because they are unlikely to be associated with customer locations.[88] In addition, we note that PNR's reliance on the Census Bureau's TIGER files ensures a degree of reliability and availability for review of much of the data underlying PNR's road surrogate algorithm, in compliance with criterion eight of the *Universal Service Order*.[89] We note that the HAI proponents contend that use of a surrogate algorithm may overstate the amount of plant necessary to provide supported services.[90] We seek comment on the validity of this contention. We also note that PNR has indicated that it intends to finalize a number of improvements to the road surrogate algorithm and data.[91] For example, PNR states that the new release will incorporate any new input requirements relating to an authoritative wire center list, housing units versus households, and treatment of phone penetration rates. In addition, the new release will include data for all fifty states, Washington, D.C., and Puerto Rico.[92] We seek comment on our tentative conclusion to adopt the PNR road surrogate algorithm to determine customer locations, and to adopt the PNR road surrogate data set for

[86] PNR Feb. 22 *ex parte* at 2.

[87] *See* Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated December 11, 1998 (Sprint Dec. 11 *ex parte*).

[88] *Platform Order*, 13 FCC Rcd at 21341, para. 41.

[89] We also note that PNR has made the road surrogate data points available to interested parties pursuant to the provisions of the *Protective Order* in this proceeding. *See* PNR Jan. 27 *ex parte*; PNR Feb. 9 *ex parte*; PNR Feb. 22 *ex parte*.

[90] *See* Letter from Chris Frentrup, MCI, to Magalie Roman Salas, FCC, dated February 19, 1999.

[91] Letter from William M. Newman, PNR, to Magalie Roman Salas, FCC, dated February 9, 1999 (PNR Feb. 9 *ex parte*).

[92] *See* PNR Feb. 9 *ex parte* at 1.

use in the model beginning on January 1, 2000. We also seek comment on any changes that should be made to the PNR methodology to improve the accuracy of the customer locations it generates.

3. Methodology for Estimating the Number of Customer Locations

35. In addition to selecting a source of customer data, we also must select a methodology for estimating the number of customer locations within the geographic region that will be used in developing the customer location data. We also must determine how demand for service at each location should be estimated and how locations should be allocated to each wire center.

36. In the *Universal Service Order*, the Commission concluded that a "model must estimate the cost of providing service for all businesses and households within a geographic region."[93] In the *Inputs Public Notice*, the Bureau sought comment on the appropriate method for defining "households," or residential locations, for the purpose of calculating the forward-looking cost of providing supported services.[94] Model proponents and interested parties have proposed alternative methods to comply with this requirement.[95]

37. The HAI sponsors propose that we use the methodology devised by PNR, which is based upon the number of households in each Census Block, while the BCPM sponsors propose that we use a methodology based upon the number of housing units in each Census Block. A household is an occupied residence, while housing units include all residences, whether occupied or not.[96]

38. Specifically, the HAI sponsors advocate the use of the PNR National Access Line Model to estimate the number of customer locations within Census Blocks and wire

[93] *Universal Service Order*, 12 FCC Rcd at 8915, para. 250 (criterion 6).

[94] *Inputs Public Notice* at 4-6.

[95] We note that the question of which residential and business locations should be included for purposes of estimating the forward-looking cost of providing the supported services is distinct from the question of which lines should be supported. *See Universal Service Order*, 12 FCC Rcd at 8829, paras. 95-96 (declining to adopt the Joint Board's recommendation to restrict universal service high cost support to primary residential and single-line businesses).

[96] These definitions reflect the Census Bureau's methodology for housing unit and household estimates. *See* http://www.census.gov/population/methods/sthhmet.txt.

centers.[97] The PNR National Access Line Model uses a variety of information sources, including: survey information, the LERG, Business Location Research (BLR) wire center boundaries, Dun & Bradstreet's business database, Metromail's residential database, Claritas' demographic database, and U.S. Census estimates. PNR's model uses these sources to estimate the number of residential and business locations, and the number of access lines demanded at each location. The model makes these estimations for each Census Block, and for each wire center in the United States.[98]

39. At the conclusion of PNR's process for estimating the number of customer locations: (1) PNR's estimate of residential locations is greater than or equal to the Census Bureau's estimate of households, by Census Block Group, and its estimate is disaggregated to the Census Block level, (2) PNR's estimate of demand for both residential and business lines in each study area is greater than or equal to the number of access lines in the Automated Reporting and Management Information System (ARMIS) for that study area, and the estimates are available by location at the Block level, and (3) each customer location is associated with a particular wire center.[99]

40. The BCPM sponsors rely on many of the same data sources as those used in PNR's National Access Line Model. For example, BCPM 3.1 uses wire center data obtained from BLR and business line data obtained from PNR.[100] In estimating the number of residential locations, however, the BCPM sponsors use Census data that include household and housing unit counts from the 1990 Census, updated based upon 1995 Census statistics regarding household growth by county. In addition, rather than attempting to estimate demand by location at the Block level, the BCPM model builds two lines to every residential location and at least six lines to every business.

41. The synthesis model currently calculates the average cost per line by dividing the total cost of serving customer locations by the current number of lines. Because the current number of lines is used in this average cost calculation, the HAI sponsors argue that the total cost should be determined by using the current number of customer locations. The

[97] HAI Dec. 11, 1997 submission, Model Description at 21. PNR has agreed to review and explain the process used in developing the National Access Line Model with interested parties, pursuant to the terms of the *Protective Order*, at its location in Pennsylvania. *See* Letter from Charles A. White, PNR, to Thomas Mitchell, Collier, Shannon, Rill & Scott, dated April 29, 1999.

[98] HAI Dec. 11, 1997 submission, Model Description at 21.

[99] Customer locations in unserved areas, as reflected by BLR wire center boundaries, are not associated with particular wire centers. *See* Letter from Charles A. White, PNR, to Magalie Roman Salas, FCC, dated April 12, 1999.

[100] BCPM April 30, 1998 documentation, Model Methodology at 26-27.

HAI sponsors contend that "the key issue is the consistency of the numerator and denominator" in the average cost calculation. The HAI sponsors argue that other approaches are inconsistent because they select the highest possible cost numerator and divide by the lowest possible line denominator, and therefore result in larger than necessary support levels.[101] The HAI sponsors argue that, in order to be consistent, housing units must be used in the determination of total lines if they are used in the determination of total costs.[102] The HAI sponsors contend that "[i]f used consistently in this manner, building to housing units as GTE proposes is unlikely to make any difference in cost per line."[103]

42. In contrast, the BCPM sponsors and other commenters contend that the total cost should include the cost of providing service to all possible customer locations, even if some locations currently do not receive service.[104] Furthermore, the BCPM sponsors contend that if total cost is based on a smaller number of locations, support will not be sufficient to enable carriers to meet their carrier-of-last-resort obligations. The BCPM sponsors also argue that basing the estimate of residential locations on households instead of housing units will underestimate the cost of building a network that can provide universal service.[105] The BCPM sponsors, as well as some other commenters, contend that residential locations should be based on the number of housing units - whether occupied or unoccupied.[106] These commenters contend that only this approach reflects the obligation to provide service to any residence that may request it in the future.[107]

43. We tentatively conclude that PNR's process for estimating the number of customer locations should be used for developing the customer location data. We also tentatively conclude that we should use PNR's methodology for estimating the demand for

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[101] AT&T and MCI *ex parte*, Dec. 23, 1997.

[102] Letter from Chris Frentrup, MCI, to Magalie Roman Salas, FCC, dated March 5, 1999 (MCI March 5 *ex parte*).

[103] MCI March 5 *ex parte* (Issues 1 and 2).

[104] *See, e.g.*, BCPM Joint Sponsors *Inputs Public Notice* comments at 7; GTE *Inputs Public Notice* comments at 9; RUS *Inputs Public Notice* comments at 2.

[105] BCPM Joint Sponsors *Inputs Public Notice* comments at 6-7.

[106] *See, e.g.*, BCPM Joint Sponsors *Inputs Public Notice* comments at 7; GTE *Inputs Public Notice* comments at 9; RUS *Inputs Public Notice* comments at 2.

[107] *See, e.g.*, BCPM Joint Sponsors *Inputs Public Notice* comments at 7; GTE *Inputs Public Notice* comments at 9; RUS *Inputs Public Notice* comments at 2.

service at each location, and for allocating customer locations to wire centers.[108] We believe that the PNR methodology is a reasonable method for determining the number of customer locations to be served in calculating the cost of providing supported services. To the extent that the PNR methodology includes the cost of providing service to all currently served households, we tentatively conclude that this is consistent with a forward-looking cost model, which is designed to estimate the cost of serving current demand. As noted by the HAI sponsors, adopting housing units as the standard would inflate the cost per line by using the highest possible numerator (all occupied and unoccupied housing units) and dividing by the lowest possible denominator (the number of customers with telephones).[109]

44. In addition, we do not believe that including the cost of providing service to all housing units will promote universal service to unserved customers or areas. We note that there is no guarantee that carriers would use any support derived from the cost of serving all housing units to provide service to these customers. Many states permit carriers to charge substantial line extension or construction fees for connecting customers in remote areas to their network. If that fee is unaffordable to a particular customer, raising the carrier's support level by including the costs of serving that customer in the model's calculations would have no effect on whether the customer actually receives service. In fact, as long as the customer remains unserved, the carriers would receive a windfall. We recognize that serving unserved customers in such circumstances is an important universal service goal. As discussed in the companion Order and Further Notice adopted today, we will initiate a separate proceeding in July 1999 to investigate the issue of unserved areas.[110]

45. If we were to calculate the costs of a network that would serve all potential customers, it would not be consistent to calculate the cost per line by using current demand. In other words, it would not be consistent to estimate the cost per line by dividing the total cost of serving all potential customers by the number of lines currently served. We note, however, that the level and source of future demand is uncertain. Future demand might include not only demand from currently unoccupied housing units, but also demand from new housing units, or potential increases in demand from currently subscribing households. We also recognize that population or demographic changes may cause future demand levels in some areas to decline. Given the uncertainty of future demand, we are concerned that including such costs may not reflect forward-looking costs and may perpetuate the system of implicit support.

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[108] *See* Appendix B for a complete description of the PNR methodology for estimating the number of customer locations.

[109] AT&T and MCI *ex parte*, Dec. 23, 1997.

[110] After developing more fully the record on this issue, we will be better able to determine whether such unserved areas should receive federal universal service support. *Companion Order* at para. 92.

46. We recognize, however, that additional comment would be helpful with regard to certain issues. For example, if a currently vacant unit will again receive service in the near future, one might argue that it should be included in the calculation of total cost. It is also possible that housing stock is subject to a type of churn that could inflate the number of households used in determining total cost without affecting the total number of lines. That is, a certain percentage of housing units may be repeatedly vacated and then reoccupied, with the specific households involved constantly changing. At any given time, a certain number of housing units might be unoccupied as a result. Under the Census definition, such units are not considered households and therefore may not be included in the number of residential locations estimated by PNR.[111] We seek comment on whether the costs associated with providing service to these housing units should be included in the total cost by identifying an additional number of unoccupied units. The PNR methodology may provide an estimate of the number of residential locations that is greater than the number that currently receive telephone service, however.[112] Therefore PNR's methodology may already account for at least some portion of housing units subject to this type of churn. We seek comment on this issue.

47. We also note that locations outside of existing wire centers will not be included under the PNR methodology.[113] Therefore the accuracy of the wire center boundaries is of importance in estimating the number of customer locations. PNR currently uses BLR wire center information to estimate wire center boundaries.[114] As noted above, the BCPM model also uses BLR wire center boundaries, as does Stopwatch Maps in its road surrogate customer location files.[115] PNR has indicated its intent to evaluate alternative sources of wire center boundaries to be used in the customer location data.[116] We therefore seek comment on the accuracy of the BLR wire center boundaries and any possible alternatives to establish more accurate wire center boundaries.

V. OUTSIDE PLANT INPUT VALUES

[111] As explained in Appendix B, PNR uses two databases, Metromail and Claritas, to estimate the number of residential locations and uses whichever number is greater. Claritas uses updated Census estimates of the number of households, so in cases where the Claritas number is larger, PNR's estimate would not include unoccupied housing units. In cases where the Metromail number is larger, PNR's estimate could include unoccupied housing units, but these housing units would have an associated telephone number.

[112] As explained in Appendix B, the Metromail counts used by PNR have an associated telephone number. The Claritas household counts, on the other hand, are not restricted to households with telephones.

[113] *See supra* note 99.

[114] HAI Dec. 11, 1997 submission, Model Description at 21.

[115] *See* Sprint Dec. 11, 1998 *ex parte*, attachment at 1.

[116] Letter from Charles A. White, PNR, to Magalie Roman Salas, FCC, dated April 12, 1999.

A. Background

48. As the Commission noted in the *Platform Order*, outside plant, or loop plant, constitutes the largest portion of total network investment, particularly in rural areas.[117] Outside plant investment includes the copper cables in the distribution plant and the copper and optical fiber cables in the feeder plant that connect the customers' premises to the central office. Cable costs include the material costs of the cable, as well as the costs of installing the cable.[118]

49. Outside plant consists of a mix of aerial, underground, and buried cable.[119] Aerial cable is strung between poles above ground. Underground cable is placed underground within conduits for added support and protection. Buried cable is placed underground but without any conduit. A significant portion of outside plant investment consists of the poles, trenches, conduits, and other structure that support or house the copper and fiber cables. In some cases, electric utilities, cable companies, and other telecommunications providers share structure with the LEC and, therefore, only a portion of the costs associated with that structure are borne by the LEC. Outside plant investment also includes the cost of the SAIs and DLCs that connect the feeder and distribution plant.

50. The *Universal Service Order's* first criterion specifies that "[t]he technology assumed in the cost study or model must be the least-cost, most efficient, and reasonable technology for providing the supported services that is currently being deployed."[120] Thus, while the synthesis model uses existing incumbent LEC wire center locations in designing outside plant,[121] it does not necessarily reflect existing incumbent LEC loop plant. Indeed, as the Commission stated in the *Platform Order*, "[e]xisting incumbent LEC plant is not likely to reflect forward-looking technology or design choices."[122] If the prices of fiber cable and DLCs have decreased over time relative to the cost of copper cable, for example, the synthesis model would design outside plant with more fiber and DLCs and less copper cable

[117] *Platform Order*, 13 FCC Rcd at 21335, para. 27.

[118] As discussed below, cable installation costs for buried cable often are included with the structure costs.

[119] The phrase "plant mix" refers to the ratio of outside plant that is aerial, underground, or buried in a network or particular area.

[120] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250.

[121] *See supra* para. 11; *Universal Service Order*, 12 FCC Rcd at 8913, para. 250.

[122] *Platform Order*, 12 FCC Rcd at 21350, para. 66. "Instead, incumbent LECs' existing plant will tend to reflect choices made at a time when different technology options existed or when the relative cost of equipment to labor may have been different than it is today." *Id.*

than has been deployed historically in an incumbent LEC's network.[123]

B. Copper and Fiber Cable

1. Background

51. In the *1997 Further Notice*, the Commission sought comment on the input values that the model should use for cable material and installation costs.[124] The Commission specifically sought comment on the accuracy of the default values in the BCPM and HAI models and encouraged companies to submit data to support their positions.[125] The Commission tentatively concluded that cable material and installation costs should be separately identified by both density zone and terrain type.[126] Because the Commission had received no documentation confirming that feeder and distribution cable installation costs should differ, the Commission tentatively concluded that the federal mechanism should adopt HAI's assumption that such costs are identical.[127]

52. In the *Inputs Public Notice*, the Bureau sought comment on the analysis of David Gabel and Scott Kennedy on data from the Rural Utilities Service (RUS) regarding the cost of installing cables.[128] On December 11, 1998, the Bureau held a public workshop designed to elicit comment on the input values for materials costs.[129] At the workshop, Dr.

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[123] If we look at current deployment, an incumbent LEC may be deploying even more fiber and DLCs today than the optimizing routines in the synthesis model would predict. For example, a LEC building a network that is capable of delivering video and broadband services may deploy less copper than the synthesis model would estimate is the optimum amount needed to provide the services supported by the federal mechanism.

[124] *1997 Further Notice*, 12 FCC Rcd at 18544.

[125] *1997 Further Notice*, 12 FCC Rcd at 18544. The BCPM and HAI default values are the default input values for the user-adjustable input values in the BCPM and HAI models, respectively. Although we have chosen a model platform and therefore are no longer considering adoption of the BCPM and HAI models, we continue to consider the BCPM and HAI default input values in this phase of the proceeding. For some inputs, these are the only values on the record. Although the BCPM model includes nationwide default values, the BCPM sponsors generally advocate company-specific values and in some cases have proposed such values.

[126] *1997 Further Notice*, 12 FCC Rcd at 18544.

[127] *1997 Further Notice*, 12 FCC Rcd at 18544.

[128] *Inputs Public Notice* at 7. *See* David Gabel & Scott Kennedy, *Estimating the Cost of Switching and Cables Based on Publicly Available Data* (National Regulatory Research Institute NRRI 98-09, April 1998) (NRRI Study). Dr. Gabel and Mr. Kennedy are consultants for the Commission in this proceeding.

[129] *See Workshop Public Notice*. The December 1, 1998 workshop addressed issues relating to switching and expenses.

Gabel presented the methodology used by the Commission staff to derive preliminary values for cable costs based on his earlier analysis of the RUS data.

53. Commission staff sought to supplement the record with respect to outside plant structure and cable costs by requesting additional data from LECs, including competitive LECs.[130] A copy of the outside plant structure and cable cost survey is attached in Appendix C. Ten companies eventually responded to the voluntary survey, somewhat fewer than the number that had indicated they would be willing to provide data.[131] Because of the delay in receiving the data and the time necessary to review and revise the data, staff has not completed its analysis of the survey data.

2. Issues for Comment

54. We now examine the inputs needed to determine outside plant cable costs in the synthesis model. The synthesis model uses several tables to calculate cable costs, based on the cost per foot of cable, which may vary by cable size (*i.e.*, gauge and pair size) and the type of plant (*i.e.*, underground, buried, or aerial). There are four separate tables for copper distribution and feeder cable of two different gauges, and one table for fiber cable. The engineering assumptions and optimizing routines in the model, in conjunction with the input values in the tables, determine which type of cable is used.

55. After the synthesis model has grouped customer locations in clusters, it determines, based on cost minimization and engineering considerations, the appropriate technology type for the cluster and the correct size of cables in the distribution network. Every customer location is connected to the closest SAI by copper cable. The copper cable used in the local loop typically is either 24- or 26-gauge copper. Twenty-four gauge copper is thicker and therefore is expected to be more expensive than 26-gauge copper. Twenty-four gauge copper also can carry signals greater distances without degradation than 26-gauge copper and, therefore, is used in longer loops. In the synthesis model, if the maximum distance from the customer to the SAI is less than or equal to the copper gauge crossover point, then 26-gauge cable is used. Feeder cable is either copper or fiber. Fiber is used for loops that exceed 18,000 feet, the maximum copper loop length permitted in the model, as

[130] After numerous discussions with industry during development of the survey, staff distributed a final version on December 14, 1998, and requested responses by January 14, 1999.

[131] BellSouth, Ameritech, Pacific Bell, Nevada Bell, Southwestern Bell, Sprint, GTE, Aliant, SNET, and AT&T submitted data in response to the structure and cable cost survey. Several companies requested additional time to complete and submit their data. After receiving and reviewing the data, staff found that, despite detailed survey instructions, further discussions with a number of companies were required before staff could assemble the data for comparison and analysis. In a number of cases, respondents filed revised data or clarified the data they had submitted.

determined in the *Platform Order*.[132] When fiber is more cost effective, the model will use it to replace copper for loops that are shorter than 18,000 feet.

a. Engineering Assumptions and Optimizing Routines

56. Before we consider our proposed input values for cable costs, we discuss certain input values related to the engineering assumptions and optimizing routines in the synthesis model that affect outside plant costs. Specifically, we must determine: (1) whether optimization in the synthesis model should be turned on or off; (2) whether the model should use T-1 technology; and (3) whether the model should use rectilinear or airline distances and the value of the corresponding "road factor."

i. Optimization

57. In the synthesis model, the user has the option of optimizing distribution plant routing via a minimum cost spanning tree algorithm discussed in the model documentation.[133] The algorithm functions by first calculating distribution routing using an engineering "rule of thumb" and then comparing the cost with the spanning tree result, choosing the routing that minimizes annualized cost.[134] The user also has the option of not using the distribution optimization feature, thereby saving a significant amount of computation time, but reporting network costs that may be significantly higher than with the optimization. In addition, the user has the option of using the distribution optimization feature only in the lowest density zones.

58. We tentatively conclude that the synthesis model should be run with the optimization turned on when the model is used to calculate the forward looking cost of providing the services supported by the federal mechanism. We point out that the optimization approach represents what a network planning engineer would attempt to accomplish in developing a forward-looking network. This approach also complies with criterion one's requirement that the model must assume the least-cost, most efficient, and reasonable technology for providing the supported service that is currently being deployed. We note, however, that the optimization can substantially increase the model's run time. Preliminary staff analysis of comparison runs with full optimization versus runs with no optimization indicate that, for clusters with line density greater than 500, the rule of thumb

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[132] *Platform Order*, 13 FCC Rcd at 21352-53, para. 70.

[133] The synthesis model always optimizes feeder plant. *See* C.A. Bush, et al., The Hybrid Cost Proxy Model Customer Location and Loop Design Modules, Dec. 15, 1998 (HCPM Dec. 15, 1998 documentation) at 13.

[134] *Id.* at 11.

algorithm results in the same or lower cost for nearly all clusters.[135] We seek comment on whether an acceptable compromise to full optimization would be to set the optimization factor at "-p500," as described in the model documentation.[136] With this setting the model will optimize distribution plant whenever the density of a cluster is less than or equal to 500 lines per square mile. For purposes of further analysis of the proposed input values, we also anticipate that parties may wish to run the model without optimization turned on to save computing time. After staff has completed its analysis of comparison runs, we intend to make available a spreadsheet showing the estimated percentage change, for each non-rural study area, between running the model with the distribution optimization disabled and running the model with the distribution optimization enabled.

ii. T-1 Technology

59. A user of the synthesis model also has the option of using T-1 technology as an alternative to copper feeder or fiber feeder in certain circumstances. T-1 is a technology that allows digital signals to be transmitted on two pairs of copper wires at 1.544 Megabits per second (Mbps). If the T-1 option is enabled, the optimizing routines in the model will choose the least cost feeder technology among three options: analog copper, T-1 on copper, and fiber.[137] For serving clusters with loop distances below the maximum copper loop length, the model could choose among all three options; between 18,000 feet and the fiber crossover point, which earlier versions of HCPM set at 24,000 feet, the model could choose between fiber and T-1; and above the fiber crossover point, the model would always use fiber. In the HAI model, T-1 technology is used to serve very small outlier clusters in locations where the copper distribution cable would exceed 18,000 feet. The BCPM sponsors and other LECs contend that T-1 is not a forward looking technology and, therefore should not be used in the synthesis model. The HAI sponsors contend that current advertisements show that T-1 is being used currently.[138]

60. As noted, a number of parties contend that the T-1 on copper technology is not forward looking. Other sources indicate that advanced technologies, like HDSL, potentially

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[135] Since, under full optimization, the model chooses the least cost of the full optimization algorithm or the rule of thumb algorithm, a comparison run as described above can show how well the full optimization performs as a function of density.

[136] *See* C.A. Bush, et al., The Hybrid Cost Proxy Model Customer Location and Loop Design Modules (Dec. 15, 1998) at 30-31; *see also* Design History of HCPM, April 6, 1999 at http://www.fcc.gov/ccb/apd/hcpm.

[137] HCPM Dec. 15, 1998 documentation at 10.

[138] *See* Letter from Richard N. Clarke, AT&T, to Magalie Roman Salas, dated March 17, 1999, at Attachment A.

can be used on T-1 technology to transmit information at T-1 or higher rates.[139] We seek comment on this issue. We also seek comment on the extent to which HDSL technology presently is being used on T-1.

61. The only input values for T-1 costs on the record in this proceeding are the HAI default values.[140] Because the synthesis model and the HAI model use T-1 differently, we tentatively find that the HAI default values would not be appropriate for use in the synthesis model. In light of the fact that T-1 may not be a forward looking technology and the lack of appropriate input values, we tentatively conclude that we should not use the T-1 option in the synthesis model. We seek comment on our tentative conclusion. We ask that parties who disagree with our tentative conclusion and recommend that the T-1 function be used in the synthesis model propose input values that will accurately estimate the cost of this technology, including what values are needed for the costs of shielded copper, repeaters, and terminals.

iii. Distance Calculations and Road Factor

62. We tentatively conclude that the synthesis model should use rectilinear distance, rather than airline distance, in calculating outside plant distances,[141] because this more accurately reflects the routing of telephone plant along roads and other rights of way. In fact, research suggests that, on average, rectilinear distance closely approximates road distances.[142] As a result, we tentatively conclude that the road factor in the model, which reflects the ratio between route distance and road distance, should be set equal to 1. We seek comment on these tentative conclusions.

63. We also note that airline distance could be used in the model, if we were to derive accurate road factors. We seek comment on this alternative. Specifically, we seek comment on whether we should use airline miles with wire center specific road factors.[143]

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[139] HDSL (high data rate digital subscriber line) transmits 1.544 Mbps or 2.048 Mbps in bandwidths ranging from 80 kilohertz (kHz) to 240 kHz, rather than in a bandwidth of 1.5 megahertz (mHz) required for traditional T-1 services. *See* www.adsl.com/general_tutorial.

[140] The HAI sponsors provide default values for T-1 technology including the cost of repeaters and remote T-1 terminals. *See* HAI Inputs Portfolio at 45-48.

[141] In short, this means that telephone plant will be built on north-south and east-west routes, rather than "as the crow flies."

[142] *See* Robert F. Love, James G. Morris, and George O. Wesolowsky, *Facilities Location: Models and Methods*, Chapter 10 (Elsevier Science Publishing Co. 1988) (*Facilities Location Models).*

[143] Such a road factor could be calculated as follows. First, using the wire center boundaries from the customer location data, we would determine which Census Blocks are contained within each wire center. Second, we would extract the TIGER files containing road coordinates and distances for each of these Census

Research has shown that the airline distance metric with an appropriate road factor is more accurate than the rectilinear metric.[144] We seek comment on this alternative approach.

b. Cost of Copper Cable

i. Preliminary Issues

64. The synthesis model uses tables that show the cost per foot of copper cable, by pair size. In selecting input values for the cost of copper cables, we must first address a number of preliminary issues: the extent to which 24- and 26- gauge copper cable should be used in the synthesis model; whether cable installation costs should differ between feeder and distribution cable; and whether cable installation costs should vary for underground, buried, and aerial cable.

65. Use of 24- and 26-Gauge Copper. The HAI default values assume that all copper cable below 400 pairs in size is 24-gauge and all copper cable of 400 pairs and larger is 26-gauge.[145] The BCPM default values include separate costs for 24- and 26-gauge copper of all sizes. We tentatively reject the HAI sponsors' argument that 26-gauge copper costs should be used for all larger pair sizes of copper cable. We tentatively conclude that the model should use both 24-gauge and 26-gauge copper in all available pair-sizes. Based on a preliminary analysis of the results of the structure and cable cost survey, it appears that a significant amount of 24-gauge copper cable in larger pair sizes currently is being deployed. We seek comment on these tentative conclusions.

66. Distinguishing Feeder and Distribution Cable Costs. We reaffirm the Commission's tentative conclusion in the *1997 Further Notice* that the same input values should be used for copper cable whether it is used in feeder or in distribution plant. Although the BCPM sponsors previously disagreed with this tentative conclusion,[146] they have not provided persuasive data for this position. We seek comment on this tentative conclusion.

Blocks. Third, we would create a database matching a sample set of coordinates of road intersections within the wire center, the road distance to an adjoining intersection, and the coordinates of the adjoining intersection. Using a formula for approximating airline distance, *see Facilities Locations Models* at 270, we could create a column containing airline distances. Fourth, we would regress road distance on airline distance to obtain the appropriate road factor for the wire center.

[144] *See Facilities Location Models*, Chapter 10. The authors find that the goodness-of-fit of a model similar to airline distance is significantly better than one incorporating rectilinear distance.

[145] HAI Inputs Portfolio at 20.

[146] BCPM Sept. 24, 1997 comments at 13. We also note that the BCPM default values now include the same costs for feeder and distribution copper cable.

67. Distinguishing Underground, Buried, and Aerial Installation Costs. The HAI and BCPM sponsors both claim that their proposed values for cable costs include the cost of installation.[147] The BCPM defaults provide separate cost estimates for aerial, buried, and underground cable. The HAI default cable costs do not vary by type of plant and, therefore, appear to assume that installation costs are the same for aerial, underground, and buried cable. For buried copper cable, the HAI defaults include a multiplier to estimate the additional cost of the filling compound used in buried cable to protect the cable from moisture.[148] For underground cable, HAI adds a per foot material cost for the conduit material.[149]

68. We tentatively conclude that we should adopt separate input values for the cost of aerial, underground, and buried cable. Based on our analysis of cable cost data, we have found considerable differences in the per foot cost of cable, depending upon whether the cable was strung on poles, pulled through conduit, or buried. We seek comment on this tentative conclusion.

ii. Cost Per Foot of Copper Cable

69. We now turn to the cost per foot of 24- and 26-gauge copper cable. Both the HAI and BCPM sponsors provide default input values for copper cable costs that are based upon the opinions of their respective experts, but without data that enable us to substantiate those opinions. In addition, the Commission received cable cost data from a number of LECs, including data received in response to the structure and cable cost survey developed by staff, which staff is continuing to analyze, as noted above.

70. At the December 11, 1998 workshop, Commission staff described how they had estimated the preliminary copper cable costs, by pair size and by plant type (*i.e.*, aerial, buried, or underground), that had been posted on the Commission's Web site prior to the workshop. For copper cable, the staff estimated high and low values for the cost of the smallest pair size of 26-gauge copper cable based on an analysis of the HAI default values and the values submitted by states filing cost models in this proceeding. These estimates were adjusted for larger pair sizes of 26-gauge cable and different structure types using estimates in Gabel and Kennedy's analysis of RUS data, which was published by the National

[147] The HAI sponsors assert that these costs include "engineering, installation, and delivery, as well as the cable material itself." HAI Inputs Portfolio at 20. The BCPM sponsors represent that their default values for cable costs include the material cost, supply cost, taxes, placing, splicing, and engineering costs. BCPM, Loop Inputs Documentation at 15.

[148] HAI Inputs Portfolio at 23.

[149] HAI Inputs Portfolio at 24.

Regulatory Research Institute (NRRI Study).[150] The cost of 24-gauge copper cable was estimated by applying a multiplier to the 26-gauge estimates based on the relative weight of the copper in these two gauges.[151]

71. While the HAI sponsors support using the publicly available RUS data in the NRRI Study to estimate cable costs,[152] Sprint questions the reliability and suitability of this data, and urges us instead to use the cable cost data provided by incumbent LECs.[153] As Sprint points out, the RUS data contain information from only the two lowest density zones.[154] Because loops are longer in sparsely populated areas, lower gauge copper often is used.

72. We tentatively conclude that we should use, with certain modifications, the estimates in the NRRI Study for the per foot cost of aerial, underground, and buried 24-gauge copper cable. As described below,[155] we also tentatively conclude that we should estimate the cost of 26-gauge copper cable by adjusting our 24-gauge estimates with ratios derived from cost data submitted by several non-rural LECs. The proposed cost estimates for 24- and 26-gauge aerial, underground, and buried copper cable in various pair sizes are shown in Appendix A. We seek comment on these tentative conclusions and proposed values.

73. Although the RUS data were collected from the two lowest density zones, we note that none of the models considered by the Commission has the capability of varying cable costs by density zones. Nor have parties proposed cable cost values that vary by density zone. We also believe that Sprint has mischaracterized the analysis of the RUS data in the NRRI Study. For example, Sprint challenges the validity of the study because some of the observations have zero values for labor or material, while failing to recognize that these values were excluded from Gabel and Kennedy's regression analysis.[156] Similarly, Sprint's complaint that Gabel and Kennedy do not analyze the components of total cable costs, labor and material, separately overlooks that Gabel and Kennedy's regression analysis is designed to

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[150] *See supra* note 128.

[151] An earlier version of HCPM calculated 24-gauge copper cable by multiplying the values for 26-gauge copper cable by 1.17. *See* HCPM Dec. 15, 1998 model description at 19.

[152] Letter from Chris Frentrup, MCI Worldcom, to Magalie Roman Salas, FCC, dated Feb. 9, 1999 (MCI Feb. 9, 1999 *ex parte*).

[153] Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated Jan 29, 1999 (Sprint Jan. 29, 1999 *ex parte*).

[154] Sprint Jan. 29, 1999 *ex parte* at 8-9.

[155] *See infra* paras. 85-86.

[156] Sprint Jan. 29 *ex parte*, attachment at 5.

explain the variation in total costs.[157]

74. The NRRI Study provides estimates for outside plant structure and cable costs using cost data derived from construction contracts supplied by the RUS for a sample of companies that operate under various soil, weather, and population density conditions.[158] In generating these estimates, Gabel and Kennedy used standard regression techniques to measure the effect of geological and density conditions on cable and structure costs.[159] In general, the econometric formulations that Gable and Kennedy developed to estimate cable costs measure the effect on these costs of cable size and the placement of two or more cables on the same route.

75. We tentatively conclude that one substantive change should be made to Gabel and Kennedy's analysis. Gabel and Kennedy used the ordinary least squares statistical technique to estimate the cost of structure and cables. The ordinary least squares technique fits a straight line to the data by minimizing the sum of squared prediction errors. The ordinary least squares technique is efficacious, however, only for a data set lacking statistical outliers.[160] Such outliers have an undue influence on regression results, since the residual associated with each outlier is squared in calculating the regression. In order to mitigate the influence of such outlier values, statisticians have developed so-called robust regression techniques for estimating regression equations. We tentatively conclude that a robust regression technique should be used for analyzing the RUS data. We seek comment on this tentative conclusion.

76. Specifically, we tentatively conclude that the robust regression technique proposed by Huber should be applied to the RUS data. Essentially, this algorithm uses a standard statistical criterion to determine the most extreme outliers, and excludes them. Thereafter, as suggested by Huber, it iteratively performs a regression, then for each

[157] Sprint Jan. 29 *ex parte*, attachment at 7.

[158] To develop these estimates, Gabel and Kennedy first developed from the raw data reflected on these contracts a data base that contains outside plant structure and cable costs. The outside plant structure and cable cost data in this data base are derived from 171 contracts for 57 companies in 27 states, adjusted to 1997 dollars. NRRI Study at 2.

[159] In these regression analyses, Gabel and Kennedy used data from the HAI model on line counts and rock, soil, and water conditions for the geographic region in which each company in the data base operates. NRRI Study at 34-36. Regression analysis is a standard method used to study the dependence of one variable, the dependent variable, on one or more other variables, the explanatory variables. It is used to predict or forecast the mean value of the dependent variable on the basis of known or expected values of the explanatory variables. For a discussion of regression analysis, *see* William H. Greene (1990), *Econometric Analysis*, New York: MacMillan Publishing Company.

[160] Statistical outliers are values that are much higher or lower than other data in the data set.

observation calculates an observation weight based on the absolute value of the observation residual. Finally, the procedure performs a weighted least squares regression using the calculated weights. This process is repeated until the values of the weights effectively stop changing. We have used the robust regression parameter estimates for cable, conduit, and buried structure. The use of robust estimation did not improve the statistical properties of the estimators for pole costs, so we tentatively conclude that the ordinary least squares technique is appropriate for pole costs.[161] We seek comment on these tentative conclusions and analysis.

77. 24-Gauge Aerial Copper Cable. We tentatively conclude that we should use the regression equation in the NRRI Study, as modified by the Huber methodology described above, to estimate the cost of 24-gauge aerial copper cable, with three adjustments.[162]

78. First, we propose to adjust the equation to reflect the superior buying power that non-rural LECs may have in comparison to the LECs represented in the RUS data. We seek comment on whether an adjustment for superior bargaining power is necessary, and, if so, how such an adjustment should be made.

79. Based on data entered into the record in a proceeding before the Maine Public Utilities Commission, Gabel and Kennedy determined that Bell Atlantic's material costs for aerial copper cable are approximately 15.2 percent less than these costs for the RUS companies.[163] We tentatively conclude that this figure represents a reasonable estimate of the difference in the material costs that non-rural LECs pay in comparison to those that the RUS companies pay. To reflect this degree of buying power in the cable cost estimates that we derive for non-rural LECs, we propose to reduce the regression coefficient for the number of copper pairs by 15.2 percent for aerial copper cable. This coefficient measures the incremental or additional cable cost associated with one additional copper pair and therefore largely reflects the material cost of the cable. We seek comment on this proposed adjustment. We also invite parties to suggest alternative methods for capturing the impact of superior buying power.

80. Second, we propose to adjust the equation in the NRRI Study to account for LEC engineering costs, which were not included in the RUS cable data. The BCM2 default values include a loading of five percent for engineering. The HAI sponsors claim that

[161] For the robust regression of the pole cost equation, the value of the F-statistic was not statistically significant at the five percent level.

[162] This modified regression equation is set forth in Appendix D, section I.A. The appendix also includes an example of how we propose to use this equation to estimate the cost of 24-gauge aerial copper cable.

[163] NRRI Study at 47.

engineering constitutes approximately 15 percent of the cost of installing outside plant cables. This percentage includes both contractor engineering and LEC engineering. The cost of contractor engineering already is reflected in the RUS cable cost data. Based on the record, we tentatively conclude that we should add a loading of 10 percent to the material and labor cost of the cable (net of LEC engineering and splicing costs) to approximate the cost of LEC engineering. We seek comment on this tentative conclusion and invite commenters to justify an alternative loading factor for LEC engineering.

81. Third, we propose to adjust the equation to account for splicing costs, which also were not included in the RUS data. In the NRRI Study, Gabel and Kennedy determined that the ratio of splicing costs to copper cable costs (excluding splicing and LEC engineering costs) is 9.4 percent for RUS companies.[164] We tentatively conclude that we should adopt a loading of 9.4 percent for splicing costs. We seek comment on this tentative conclusion.

82. 24-Gauge Underground Copper Cable. We tentatively conclude that we should use the regression equation in the NRRI Study, as modified by the Huber methodology described above, to estimate the cost of 24-gauge underground copper cable. We also tentatively conclude that we should use the same three adjustments proposed for 24-gauge aerial copper cable, with one exception.[165] We tentatively conclude that we should reduce the regression coefficient for the number of copper pairs by 16.3 percent, to reflect superior buying power, based on the analysis in the NRRI study.[166] We seek comment on the use of this equation and the proposed adjustments.

83. 24-Gauge Buried Copper Cable. We tentatively conclude that it is necessary to modify the regression equation in the NRRI Study, as modified by the Huber methodology described above, to estimate the cost of a 24-gauge buried copper cable, because the equation in the study includes labor and material costs for both buried cable and structure. Appendix D provides further detail on this proposed equation.[167] We seek comment on this tentative conclusion and proposed equation.

84. We propose to make the same three adjustments to this equation as we proposed for 24-gauge aerial and underground cables, with the exception of the adjustment for superior buying power. Because the NRRI Study does not include a recommendation for

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[164] NRRI Study at 29.

[165] *See* Appendix D, section I.B.

[166] Based on data entered into the record in the aforementioned proceeding before the Maine Commission, Gabel and Kennedy determined that Bell Atlantic's material costs for underground copper cable are approximately 16.3 percent less than these costs for the RUS companies. *See* NRRI Study at 47.

[167] *See* Appendix D, section I.C.

such an adjustment for buried cable, we tentatively conclude we should use 15.2 percent, which is the lower of the reductions used for aerial and underground cable. We seek comment on the use of these adjustments for 24-gauge buried cable.

85. 26-Gauge Copper Cable. Because the NRRI Study did not provide estimates for 26-gauge copper cable, we must either use another data source or find a method to derive these estimates from those for 24-gauge. The HAI sponsors support the proposal presented by Commission staff at the workshop to use the relative weight of copper to adjust the 24-gauge copper costs to derive 26-gauge copper costs, although they would make further adjustments to reflect the cost of 26-gauge copper for cable sizes of 400 pairs and larger.[168] The BCPM sponsors challenge the assumption that the cost of copper cable is closely tied to the relative weight of the copper in the cable.[169] Both the HAI sponsors and the BCPM sponsors argue that the cost of splicing is not directly a function of investment, but rather is primarily a function of the number of pairs to be spliced, and the distance between splices.[170] Although they agree that splicing costs should be estimated using the average cost per pair-foot, they disagree over what those costs should be.

86. We tentatively conclude that we should derive cost estimates for 26-gauge cable by adjusting our estimates for 24-gauge cable. We agree with the BCPM sponsors that the cost of copper cable should not be estimated based solely on the relative weight of the cable. Instead, we propose to use the ordinary least squares regression technique to estimate the ratio of the cost of 26-gauge to 24-gauge cable for each plant type (*i.e.*, aerial, underground, buried). We propose to estimate these ratios using data on 26-gauge and 24-gauge cable costs submitted by Aliant and Sprint and the BCPM default values for these costs.[171] While we would prefer to develop these ratios based on data from more than these three sources, we tentatively conclude that these are the best data available on the record for this purpose. We seek comment on these tentative conclusions and proposed analysis, including the regression techniques described in Appendix D.[172] We invite parties to propose alternative methods of deriving cost estimates for 26-gauge cable.

c. Cost of Fiber Cable

[168] MCI Feb. 9, 1999 *ex parte*.

[169] Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated Feb. 26, 1999 (Sprint Feb. 26, 1999 *ex parte*).

[170] MCI Feb. 9, 1999 *ex parte* at 6-7; Sprint Feb. 26, 1999 *ex parte*, attachment at 6.

[171] We are not able to use the HAI default values in addition to these data to estimate these ratios because the HAI defaults do not have separate values for 26-gauge and 24-gauge cable costs for each different cable size.

[172] *See* Appendix D, sections I.D, E, F.

87. In selecting input values for fiber cable costs, we must determine values for the cost per foot of fiber for various strand sizes for aerial, underground, and buried cable. Both the HAI and BCPM sponsors provide default input values for fiber cable costs that are based upon the opinions of their respective experts, without data enabling us to substantiate those opinions. In addition, the Commission received cable cost data from a number of LECs, including data received in response to the structure and cable cost survey, which staff is continuing to analyze, as noted above.

88. At the December 11, 1998 workshop, Commission staff described how they had computed the preliminary fiber cable costs, by pair size and by plant type (aerial, buried, or underground) that had been posted on the Commission's Web site prior to the workshop. Using a methodology similar to the one used for copper cable, staff estimated the cost of the smallest size fiber cable based on an analysis of proposed values and used the analysis in the NRRI Study to derive costs for larger sizes.

89. We tentatively conclude that we should use the RUS data and the analysis in the NRRI Study, with certain adjustments, to estimate fiber cable costs. For the reasons discussed above for copper cable, we also tentatively conclude that the cost of fiber cable will vary for aerial, underground, and buried plant. We tentatively select the input values for the per foot cost of aerial, underground, and fiber cable in various strand sizes, as shown in Appendix A. We seek comment on these tentative conclusions and proposed values.

90. Aerial Fiber Cable. We tentatively conclude that we should use the regression equation in the NRRI Study, as modified by the Huber methodology described above, to estimate the cost of aerial fiber cable, with three adjustments similar to those made for copper cable.[173] We seek comment on this tentative conclusion.

91. As noted, we propose three adjustments to the equation used in the NRRI Study to estimate the cost of aerial fiber cable. First, based on the NRRI Study, we propose to reduce by 33.8 percent the regression coefficient for the number of fiber strands, to reflect the superior buying power of non-rural LECs.[174] Second, for the reasons described earlier,[175] we tentatively conclude that we should add a loading of 10 percent to the material and labor cost of the cable (net of LEC engineering and splicing costs) to approximate the cost of LEC engineering. Finally, we tentatively conclude that we should add a loading for splicing costs

[173] This modified regression equation is set forth in Appendix D, section II.A. The appendix also includes an example of how we propose to use this equation to estimate the cost of aerial fiber cable.

[174] Based on data entered into the record in the aforementioned proceeding before the Maine Commission, Gabel and Kennedy determined that Bell Atlantic's material costs for fiber cable are approximately 33.8 percent less than these costs for the RUS companies. *See* NRRI Study at 47.

[175] *See supra* para. 80.

of 4.7 percent to the material and labor cost of the cable (net of LEC engineering and splicing costs), based on the estimates in the NRRI Study.[176] We seek comment on these tentative conclusions and proposed adjustments.

92. Underground Fiber Cable. We tentatively conclude that we should use the regression equation in the NRRI Study, as modified by the Huber methodology described above, to estimate the cost of underground fiber cable, with three adjustments similar to those made for aerial fiber cable.[177] We seek comment on this tentative conclusion.

93. As noted, we propose three adjustments to the NRRI equation for the cost of underground fiber cable. First, based on the NRRI Study, we propose to adjust downward by 27.8 percent the regression coefficient for the number of fiber strands, to reflect the superior buying power of non-rural LECs.[178] Second, for the reasons described earlier,[179] we tentatively conclude that we should add a loading of 10 percent to the material and labor cost of the cable (net of LEC engineering and splicing costs) to approximate the cost of LEC engineering. Finally, we tentatively conclude that we should add a loading for splicing costs of 4.7 percent to the material and labor cost of the cable (net of LEC engineering and splicing costs), based on the estimates in the NRRI Study.[180] We seek comment on these tentative conclusions and proposed adjustments.

94. Buried Fiber Cable. We tentatively conclude that it is necessary to modify the regression equation in the NRRI Study, as modified by the Huber methodology described above, to estimate the cost of a buried fiber cable, because the equation in the study includes labor and material costs for both buried fiber cable and structure. Appendix D provides further detail on the proposed modifications to the equation used in the NRRI Study.[181] We seek comment on this tentative conclusion and proposed equation.

95. We also propose three adjustments to the proposed equation. First, based on the NRRI Study, we propose to reduce by 27.8 percent the regression coefficient for the

[176] NRRI Study at 29.

[177] *See* Appendix D, section II.B.

[178] *See* NRRI Study at 47.

[179] *See supra* para. 80.

[180] NRRI Study at 29.

[181] *See* Appendix D, section II.C.

number of fiber strands, to reflect the superior bargaining power of non-rural LECs.[182] Second, for the reasons described earlier,[183] we tentatively conclude that we should add a loading of 10 percent to the material and labor cost of the cable (net of LEC engineering and splicing costs) to approximate the cost of LEC engineering. Finally, we tentatively conclude that we should add a loading for splicing costs of 4.7 percent to the material and labor cost of the cable (net of LEC engineering and splicing costs), based on the estimates in the NRRI Study.[184] We seek comment on these tentative conclusions and proposed adjustments.

c. Cable Fill Factors

96. In determining appropriate cable sizes, network engineers include a certain amount of spare capacity to accommodate administrative functions, such as testing and repair, and some expected amount of growth. The percentage of the total usable capacity of cable that is expected to be used to meet anticipated demand is referred to as the cable fill factor.[185] If cable fill factors are set too high, the cable will have insufficient capacity to accommodate small increases in demand or service outages. In contrast, if cable fill factors are set too low, the network could have considerable excess capacity for many years. While carriers may choose to build excess capacity for a variety of reasons, we must determine the appropriate cable fill factors to use in the federal mechanism. If the fill factors are too low, the resulting excess capacity will increase the model's cost estimates to levels higher than an efficient firm's costs, potentially resulting in excessive universal service support payments.

97. Variance Among Density Zones. In general, both the HAI and BCPM sponsors provide default fill factors for copper cable that vary by density zone, and they agree that fill

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[182] Based on data entered into the record in the aforementioned proceeding before the Maine Commission, Gabel and Kennedy determined that Bell Atlantic's material costs for underground and aerial fiber cable are approximately 33.8 and 27.8 percent lower than the RUS values. *See* NRRI Study at 47. No data are available for buried fiber. We tentatively conclude that we should use the lower of these two numbers -- 27.8 percent -- for buried fiber cable.

[183] *See supra* para. 80.

[184] NRRI Study at 29.

[185] We note that the actual fill factor may be lower than the fill factor used to design the network (sometimes referred to as administrative fill), because cable and fiber are available only in certain sizes. For example, assume a neighborhood with 100 households has a current demand of 120 telephones. Dividing the 120 pair demand by an 80 percent administrative fill factor establishes a need for 150 pairs. However, cable is not sold in 150 pair units. The company will purchase the smallest cable that is sufficient to provide 150 pairs, which is a 200 pair cable. The fill factor that occurs and is measurable, known as the effective fill, will be the number of pairs needed to meet demand, 120 pairs, divided by the number of pairs installed, 200 pair, or 60 percent.

factors should be lower in the lowest density zones.[186] HAI sponsors claim that an outside plant engineer is more interested in providing a sufficient number of spares than in the ratio of working pairs to spares, so the appropriate fill factor will vary with cable size.[187] For example, 75 percent fill in a 2400 pair cable provides 600 spares, whereas a 50 percent fill in a six pair cable provides only three spares. Because smaller cables are used in lower density zones, HAI recommends that lower fill factors be used in the lowest density zones to ensure there will be enough spares available. The BCPM sponsors claim that less dense areas require lower fill ratios because the predominant plant type is buried and it is costly to add additional capacity after installation.[188] We tentatively agree with the HAI and BCPM sponsors that fill factors for copper cable should be lower in the lowest density zones, which is reflected in the fill factors that we propose in this Notice. We seek comment of this tentative finding.

98. Distribution Fill Factors. The fill factors proposed by the HAI sponsors for distribution cable are somewhat lower than for copper feeder cable.[189] The BCPM default fill factors for distribution cable, on the other hand, currently are set at 100 percent for all density zones.[190] This difference is related to the differences between certain assumptions that were made in the HAI and BCPM models. The HAI proponents claim that the level of spare capacity provided by their default values is sufficient to meet current demand plus some amount of growth.[191] This is consistent with the HAI model's approach of designing plant to meet current demand, which on average is 1.2 lines per household. BCPM, on the other hand, designs outside plant with the assumption that every residential location has two lines, which is more than current demand. Because it is costly to add distribution plant at a later point in time, incumbent LECs typically build enough distribution plant to meet not only

[186] As explained below, default values in BCPM 3.1 for distribution cable do not vary by density zone.

[187] HAI Dec. 11, 1997 submission, Inputs Portfolio at 39, 63.

[188] BCPM 3.1 May 26, 1998 (Preliminary Edition) Loop Inputs Documentation at 51.

[189] HAI 5.0 default values range from 50 percent in the lowest density zone to 75 percent in the highest density zone for distribution cable sizing fill factors, and range from 65 percent in the lowest density zone to 75 percent in the highest density zone for copper feeder cable sizing fill factors. HAI Dec. 11, 1997 submission, Inputs Portfolio at 39, 63.

[190] BCPM Dec. 11, 1997 submission. Earlier versions of BCPM, however, had lower fill factors for distribution than for feeder. *See, e.g., Further Notice* at para. 118. Default values in BCPM 3.1 range from 75 to 85 percent for feeder cable.

[191] HAI Dec. 11, 1997 submission, Inputs Portfolio at 39, 63.